Yakima River Temperature Modeling

Purpose: Provide water temperature input to Reclamation's EDT (Ecological Diagnostic and Treatment) habitat model for the Yakima River to evaluate various water-storage alternatives as they affect fisheries on the Yakima River.

Scope: Yakima River Mainstem Reach from Roza Dam to Prosser

Today's talk: Water temperature monitoring at sites and longitudinal profiles, and the water-temperature model and preliminary results

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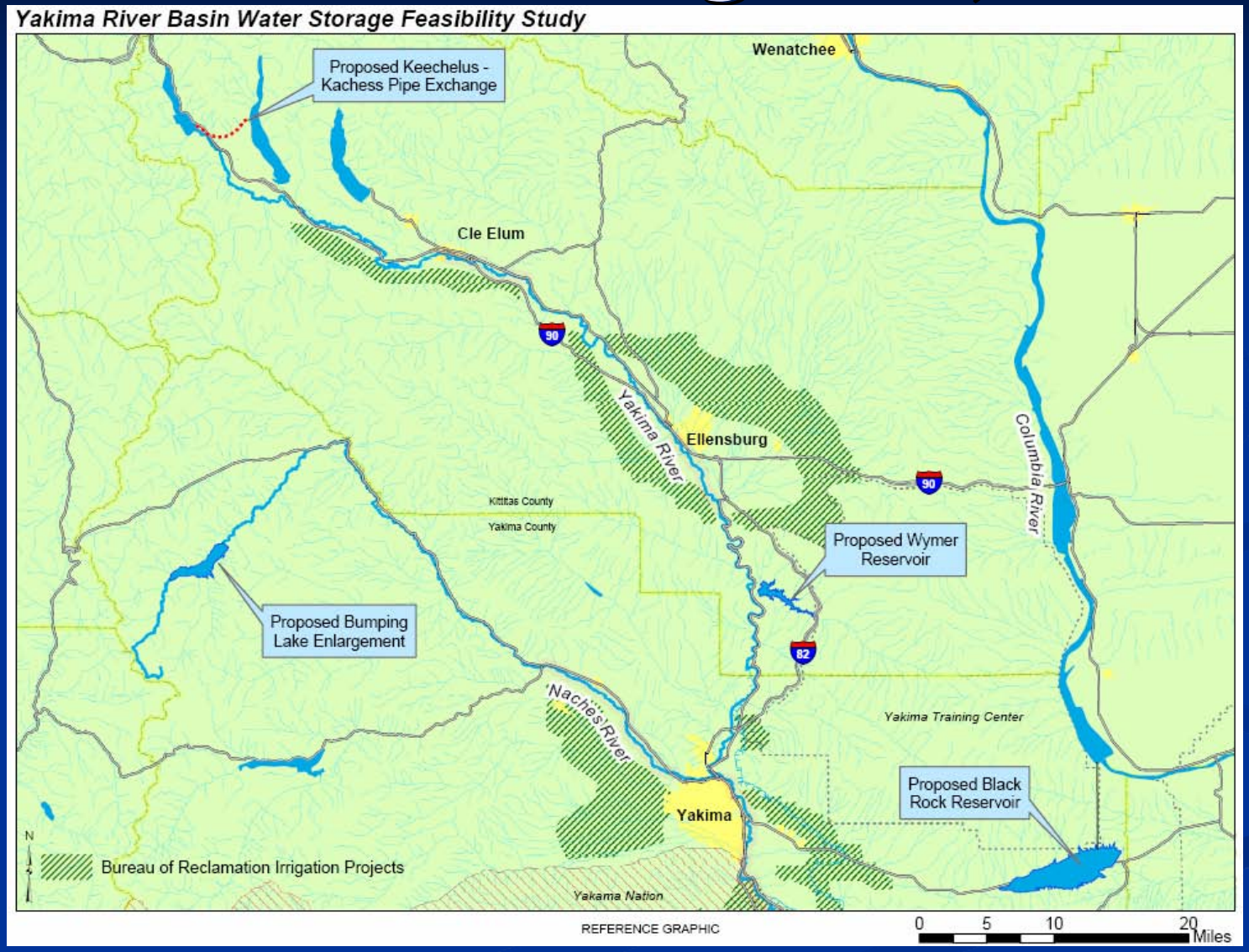
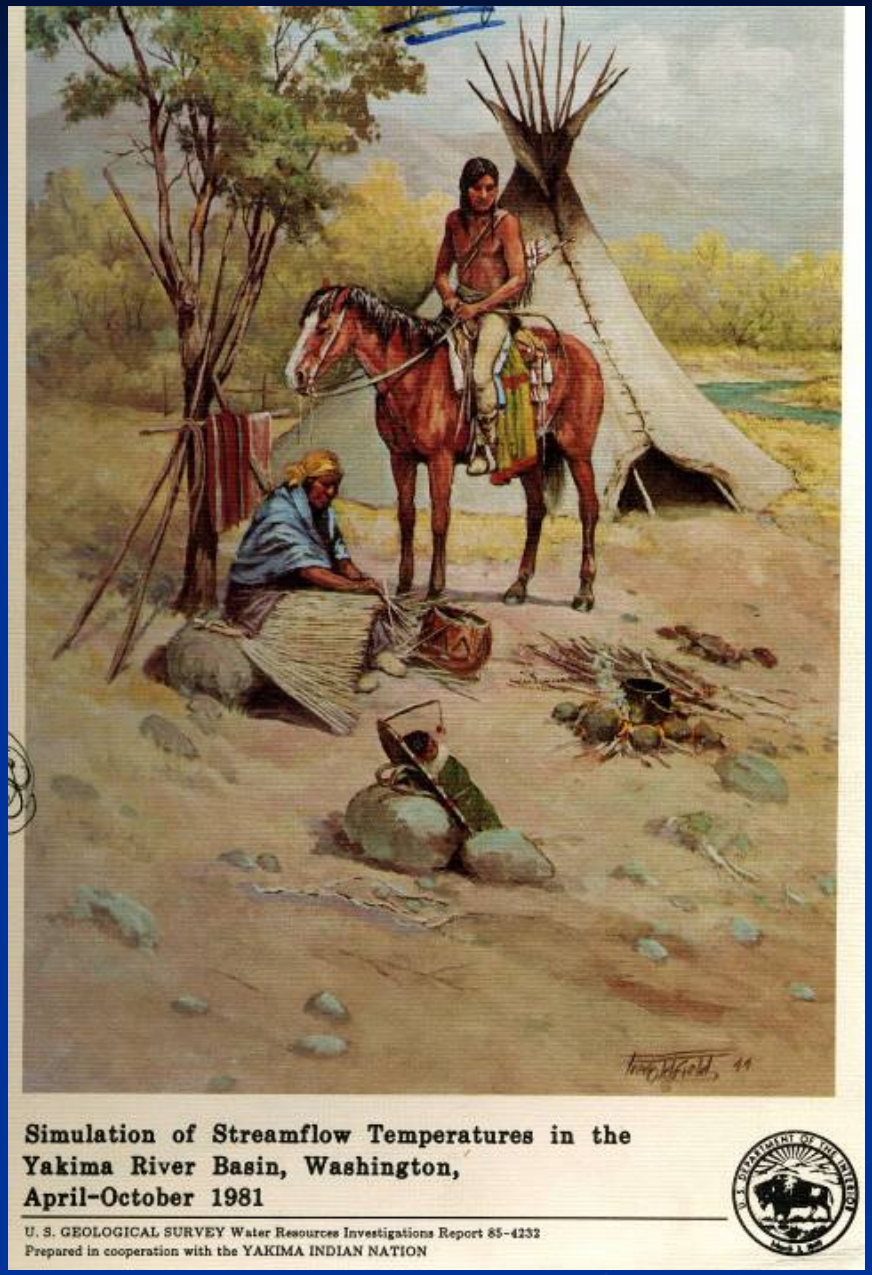
Yakima Storage Project



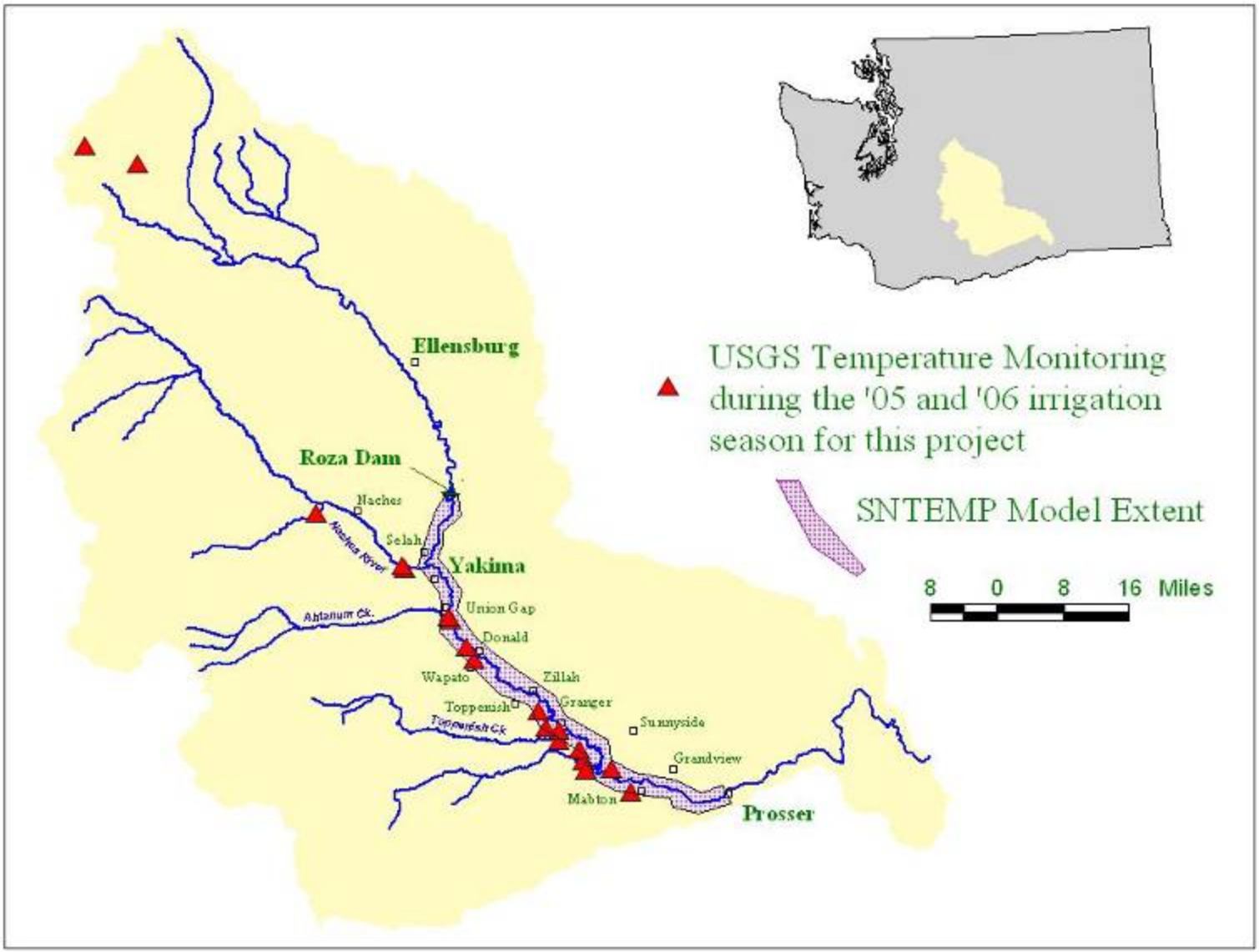
Currently USBR operates 5 reservoirs with a capacity of 1.06 M ac-ft. Irrigation demand is about 2.5 M ac-ft. Unregulated Runoff is about 4.0 M ac-ft. Storage Projects: Wymer (174,000 ac-ft) and Black Rock Reservoir (1.3 M ac-ft.).

Previous Study by John Vaccaro

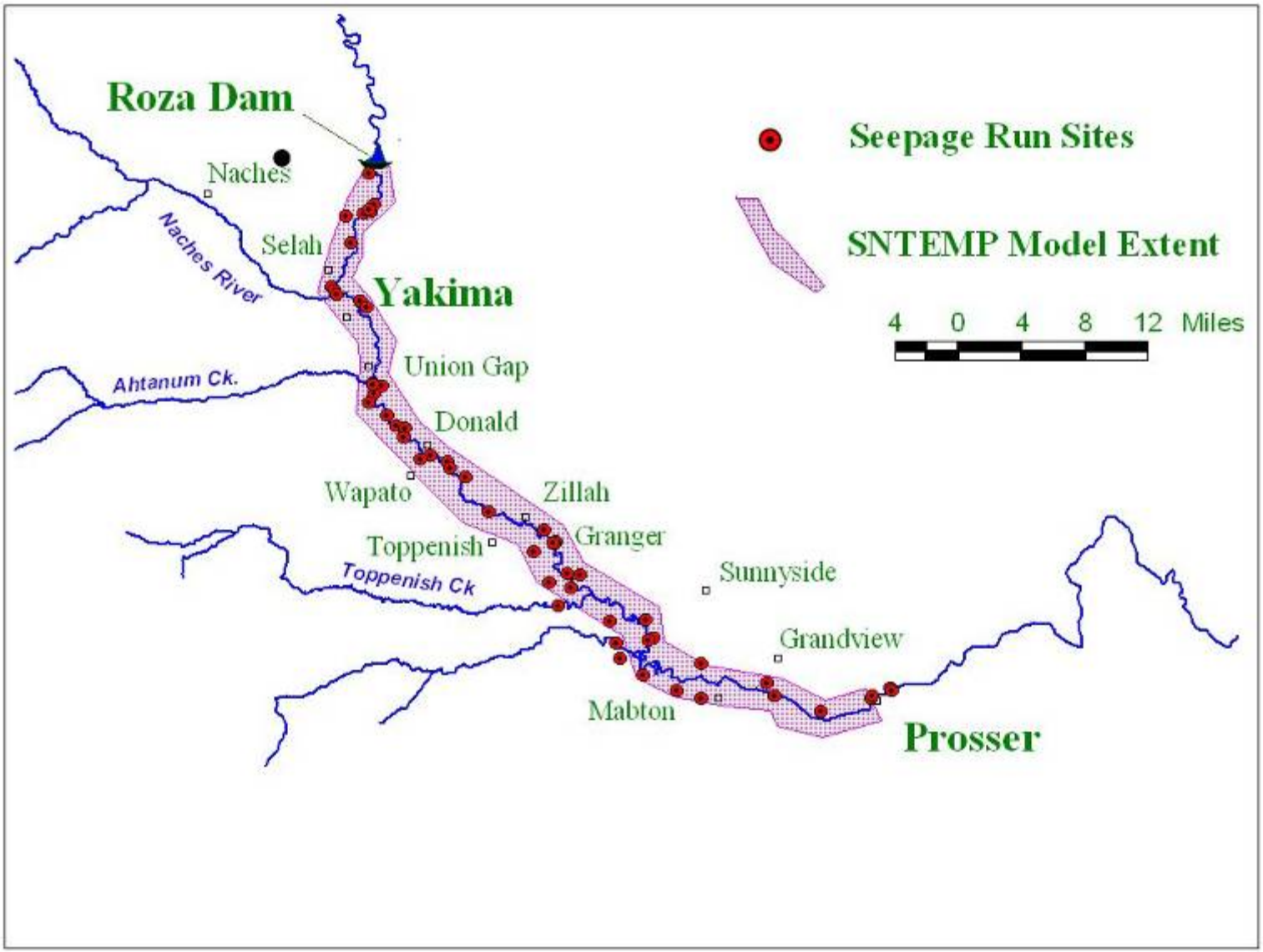


- Effect of reservoir outflow temp. diminishes downstream (4^0C increase, 1^0C increase at Umtanum and 0.01 ^{0}C increase at Prosser)
- Influence of air temp. increases downstream and dominates in lower basin (4^0C increase, 2.34^0C increase at Prosser and 1.46^0C increase at Umtanum).
- Wind had little effect on water temperature.

SNTEMP Model Extent



Seepage Run Locations

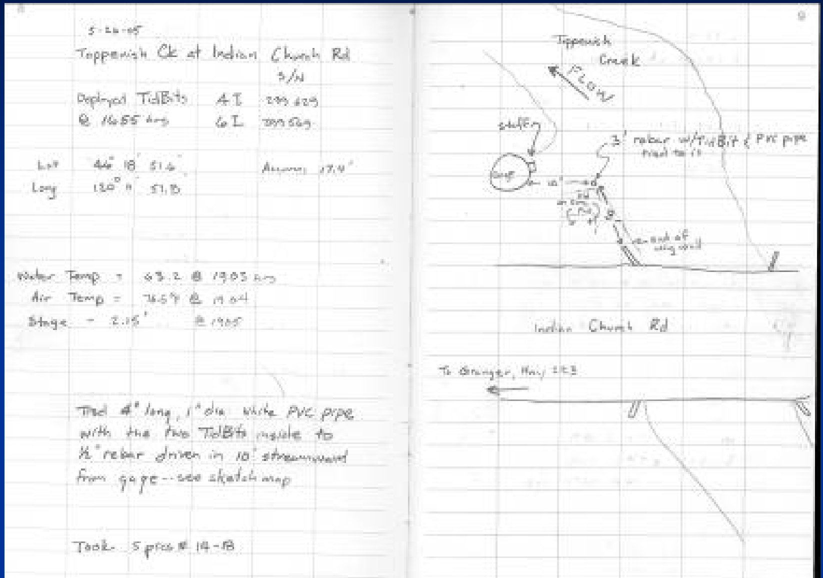


Continuous Data Collection

Tidbit Water Temperature Sensor

Near-River Met Towers—wind, solar radiation, air temperature, and relative humidity

Toppenish Creek at Indian Church Rd. 5/26/05



5-26-05
Toppenish Ck at Indian Church Rd

Deployed TidBits 4I S/N 299 629
@ 1655 hrs 6I 299 569

Lat 46° 18' 51.6" Accuracy 17.4'
Long 120° 11' 51.8

Water Temp = 63.2 @ 1903 hrs
Air Temp = 76.5°F @ 1904
Stage = 2.15' @ 1905

Tied 4' long, 1" dia white PVC pipe with the two TidBits inside to ½" rebar driven in 10' streamward from gage -- see sketch map

Took 5 pics # 14-18

Thermal Profiling Equipment

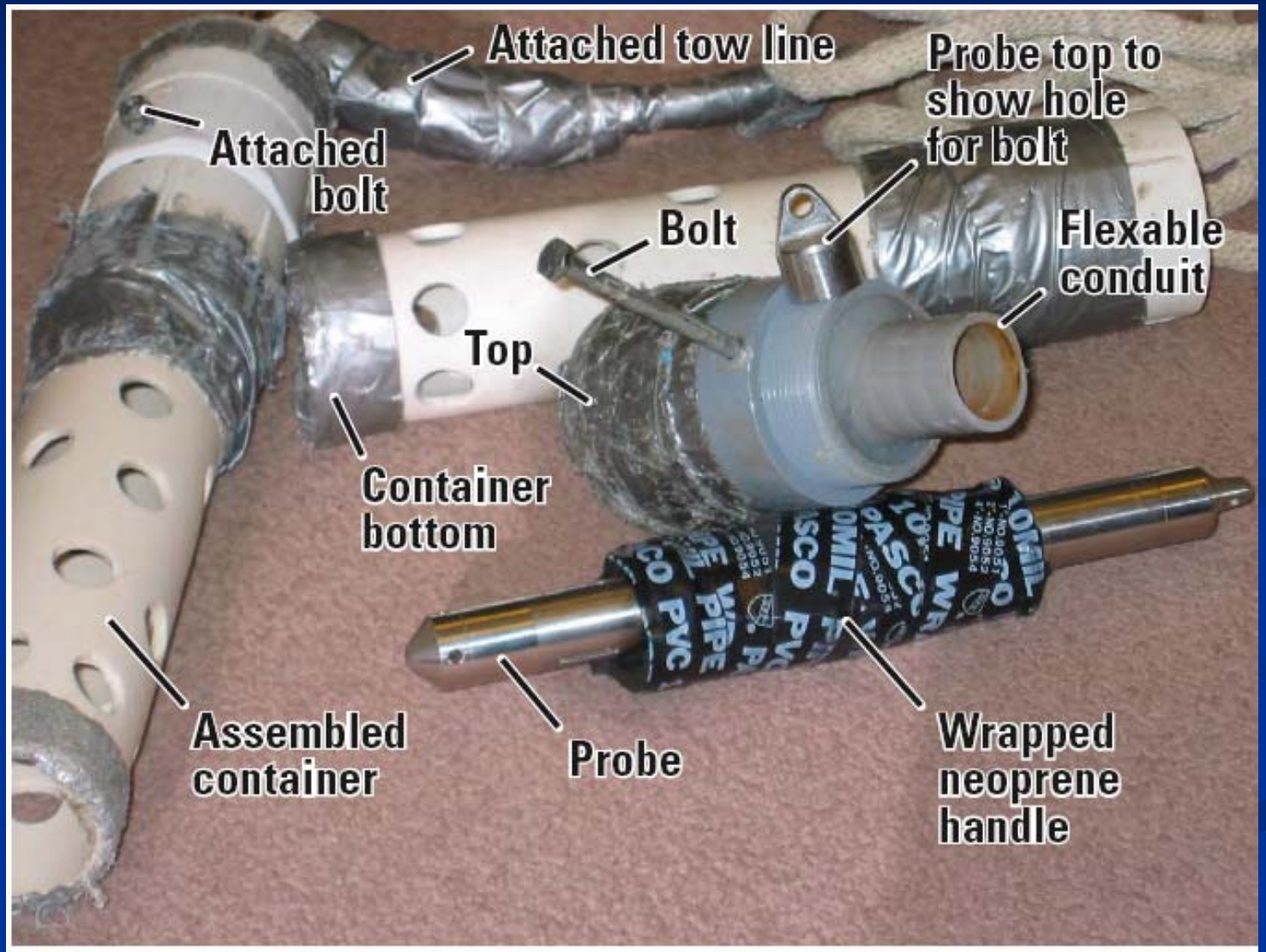
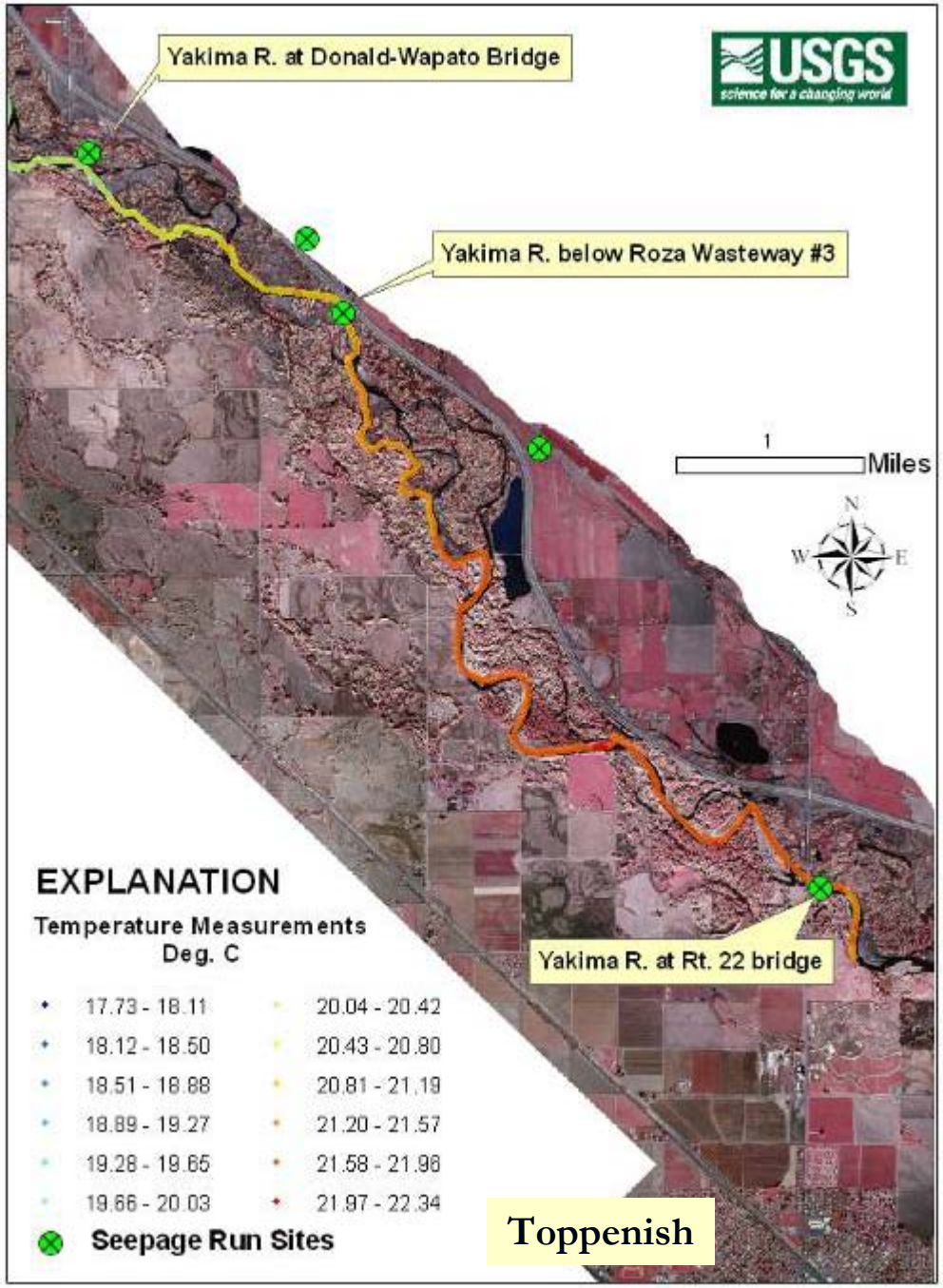
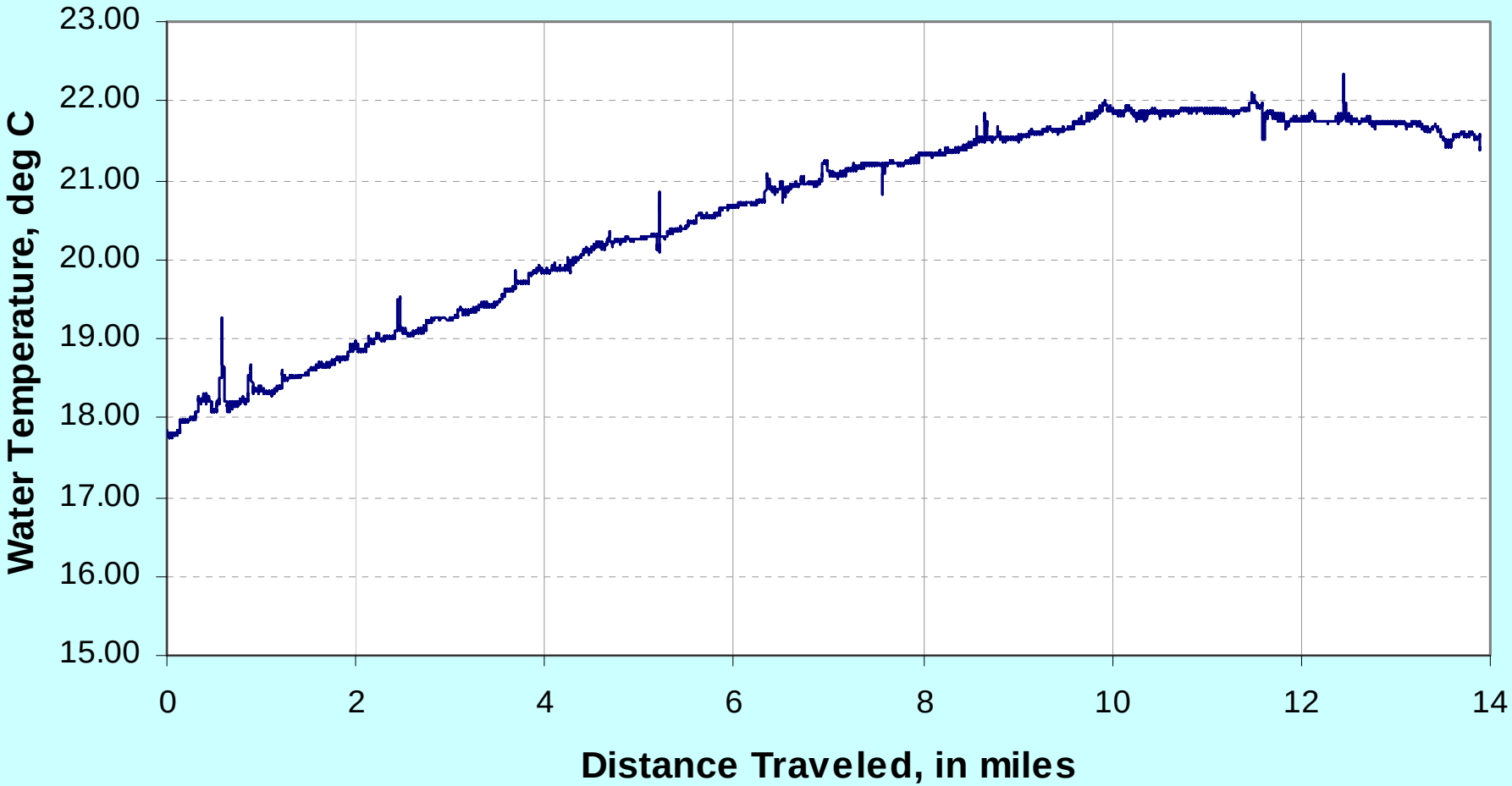


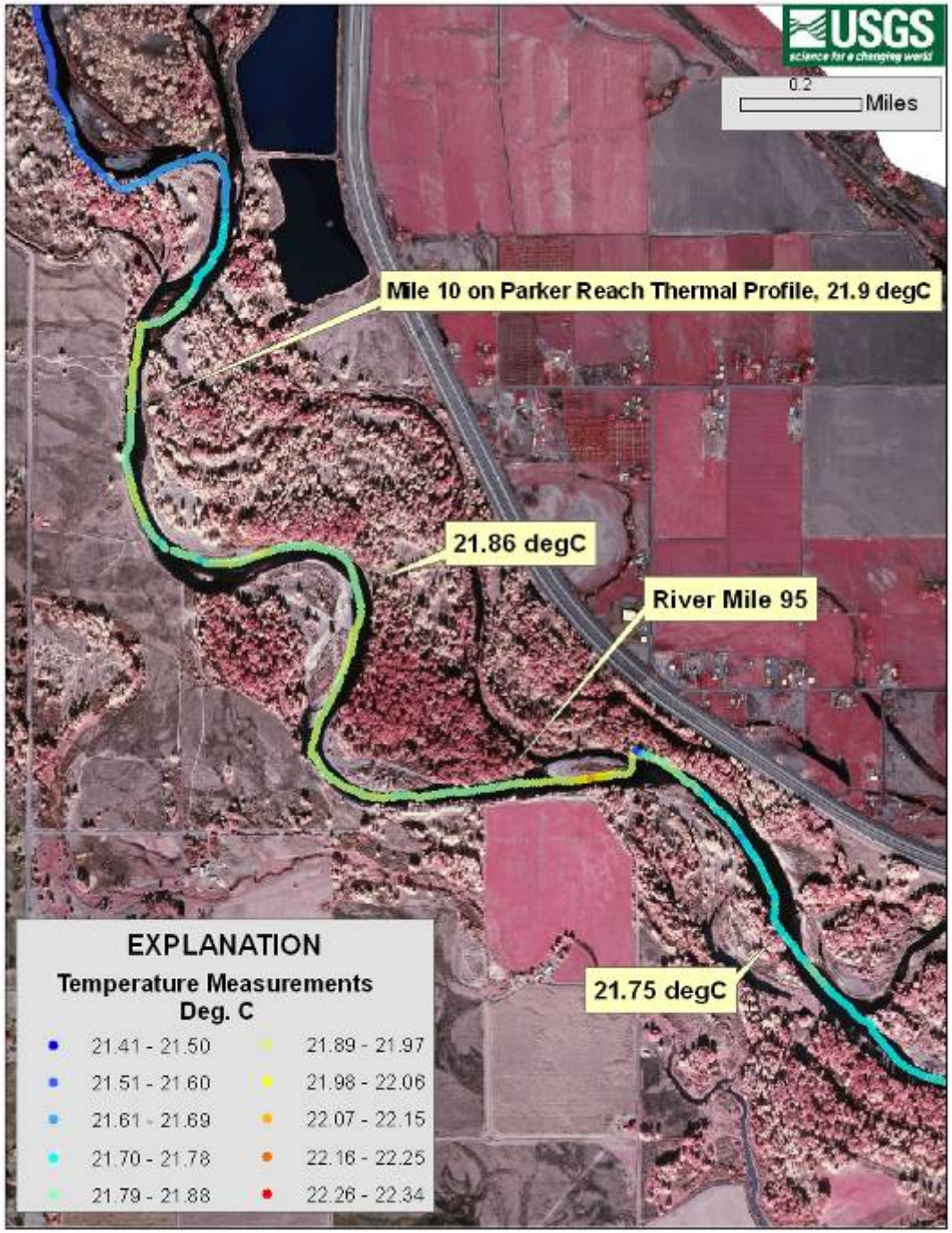
Figure 2. Temperature probe, container, and partially disassembled container.



Temperature Profile-- Parker Reach

Parker Reach-Thermal Profile





Temperature Profile-- Parker Reach

MainStem Seepage Run Results

River Mile	March '06 Gain/Loss	Sept. '05 Gain/Loss
103.6 (Yakima R. at Parker)	--	--
102.7 (Wapato Wells)	46	45
100.3 (Donald-Wapato Bridge)	90	-37
98.0 (Roza Wasteway #3)	-176	
93.1 (Rt. 22 Bridge)	240	163
86.0 (blw. E. Toppenish Drain)	123*	
83.8 (nr. Granger abv. Sub Drain 35)	-30	-37
82.9 (Hwy. 223 Bridge)	60	-13
75.6 (Yakima R. blw. Toppenish Ck.)	-144	-1

*From Roza Wasteway #3

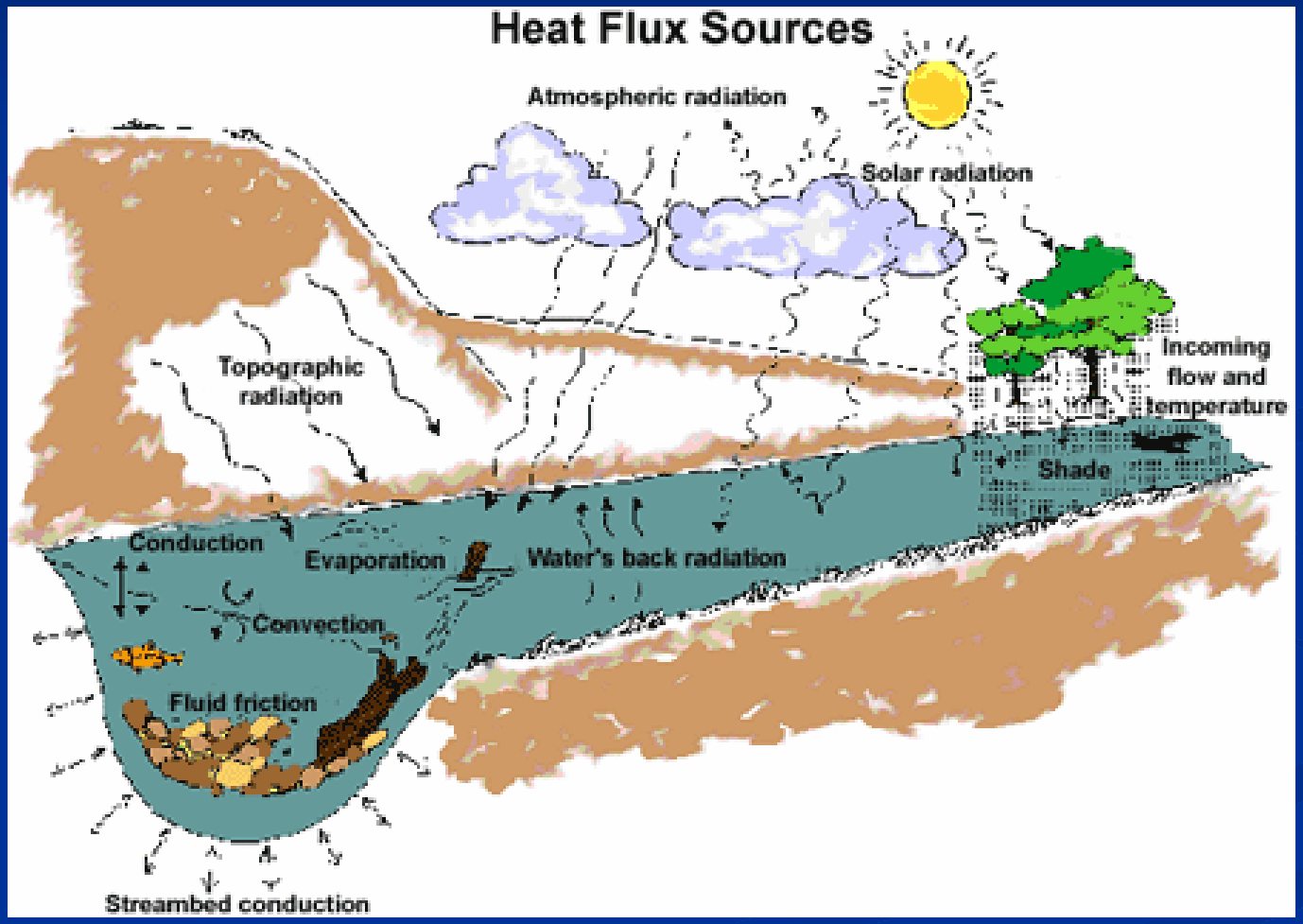
Yakima River Temperature Modeling—Approach

1. Simulate daily maximum water temperature for three 20-year scenarios to model the effects of storage alternatives.
2. Empirically determine water temperature at Roza Dam and Mouth of Naches River (boundary conditions) for given discharges.
3. Construct an SNTEMP water-temperature model for the Mainstem Reach. SNTEMP needs:
   - Water temperature and discharge for inflows and outflows
   - Shading data, Channel Width versus Discharge
   - Meteorological data
     - Air temperature
     - Wind
     - Solar Radiation

Yakima River Temperature Modeling—Approach, continued

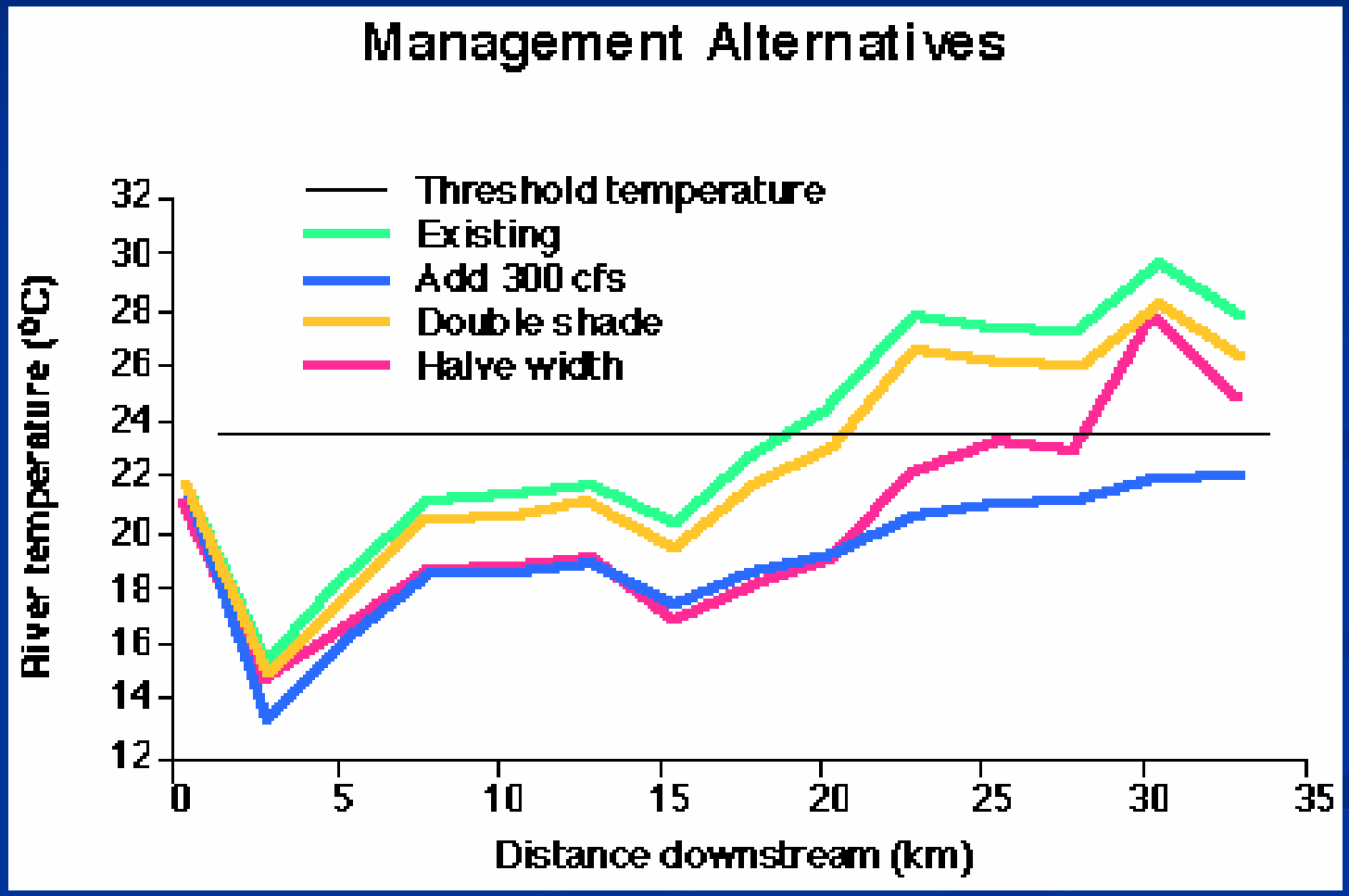
4. Collect water temperature data at a number of the larger tributaries and returns
5. Conduct seepage runs to compute ground-water inflow and water balance along mainstem reach, tributaries and returns
6. Calibrate SNTEMP model with ’05 WY data
7. Model Evaluation with temperature data collected through Sept. ‘06

SNTEMP—Water Temperature Model

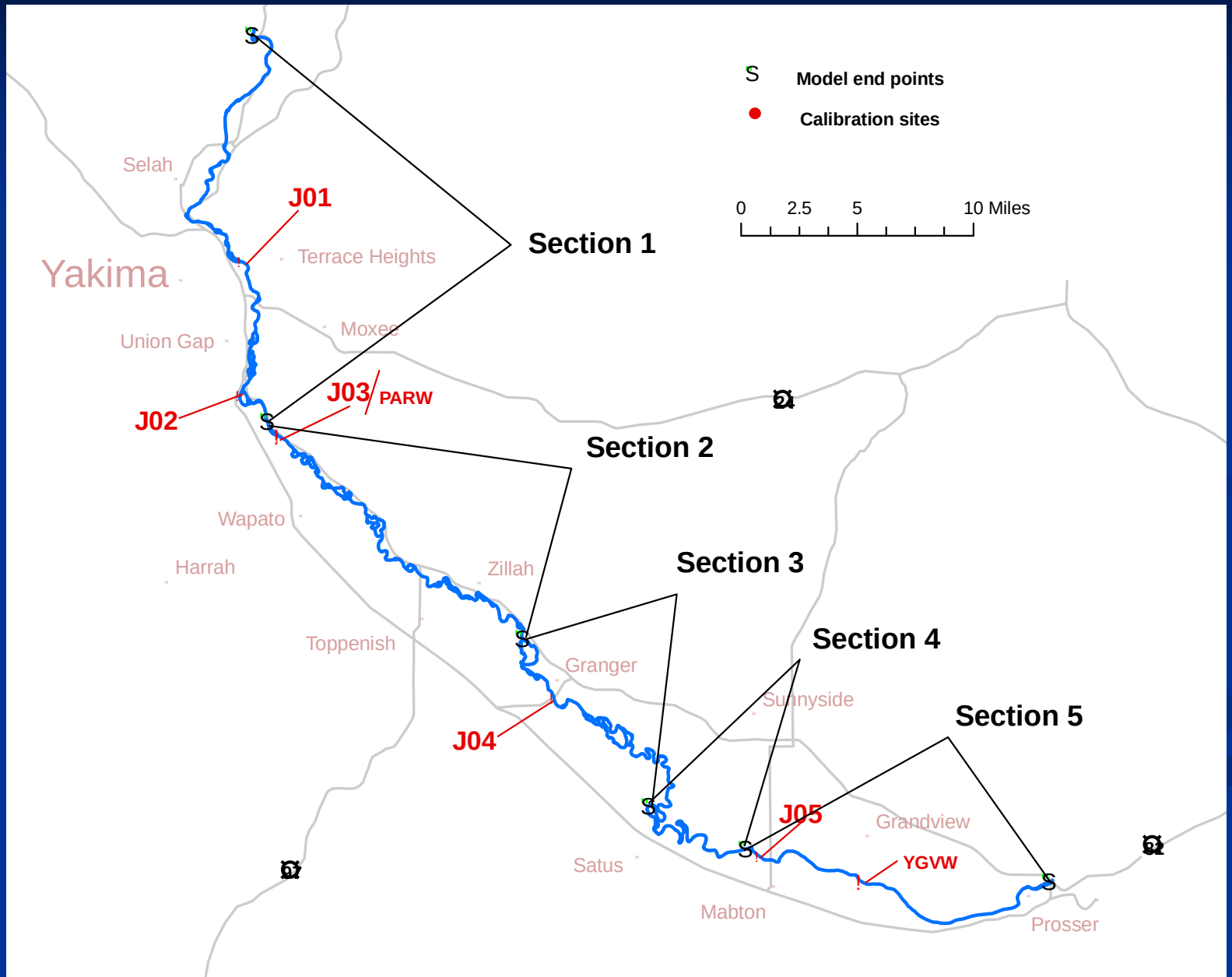


- 1D
- Daily Time Step
- Net Heat Flux
  - long- and short-wave
  - solar radiation
  - convection
  - conduction
  - evaportaion
  - shading
  - streambed friction
- Groundwater influx
- Steady-flow transport

SNTEMP—Water Temperature Model



Five SNTEMP Models in Series



Model Diagram

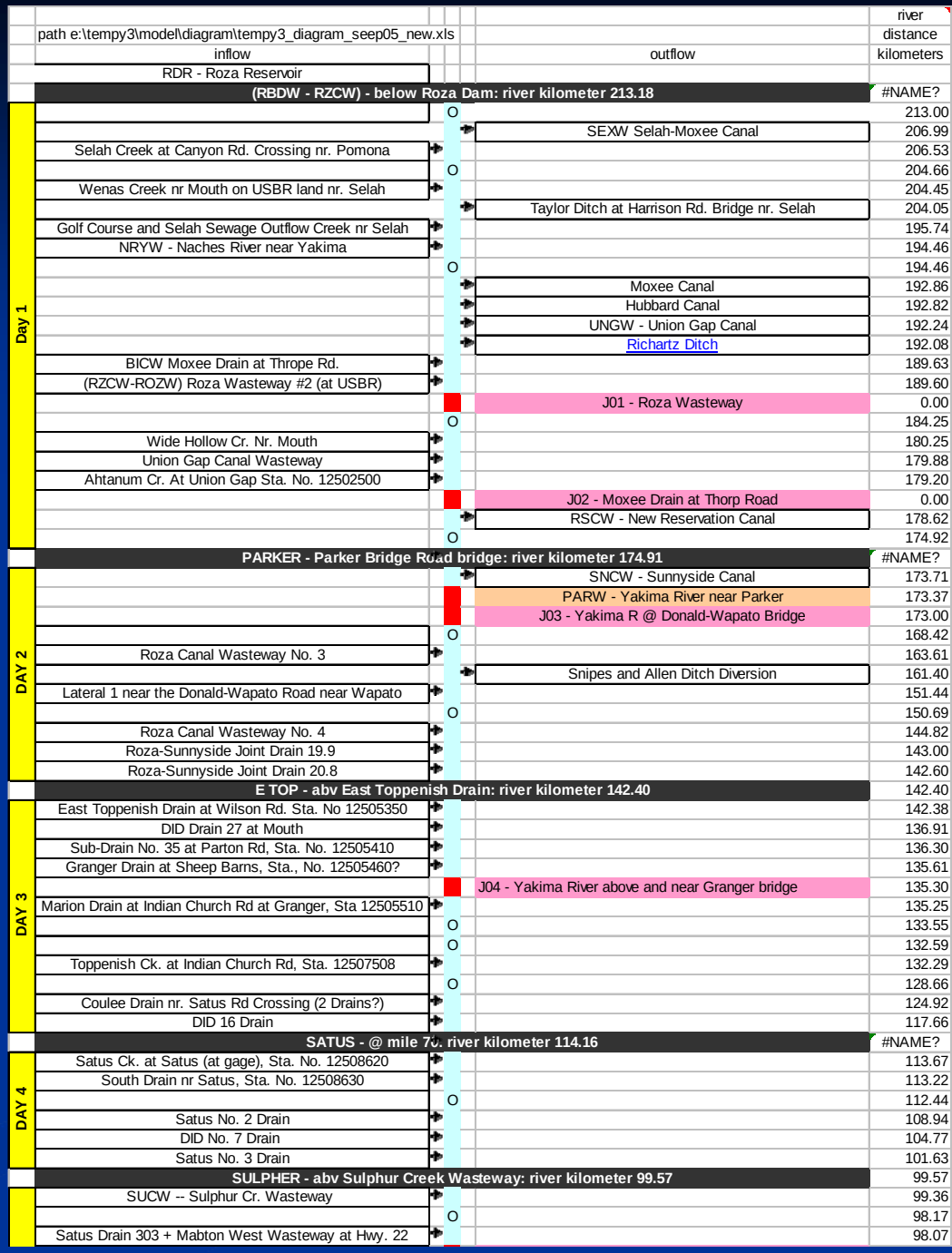
Section 1

Section 2

Section 3

Section 4

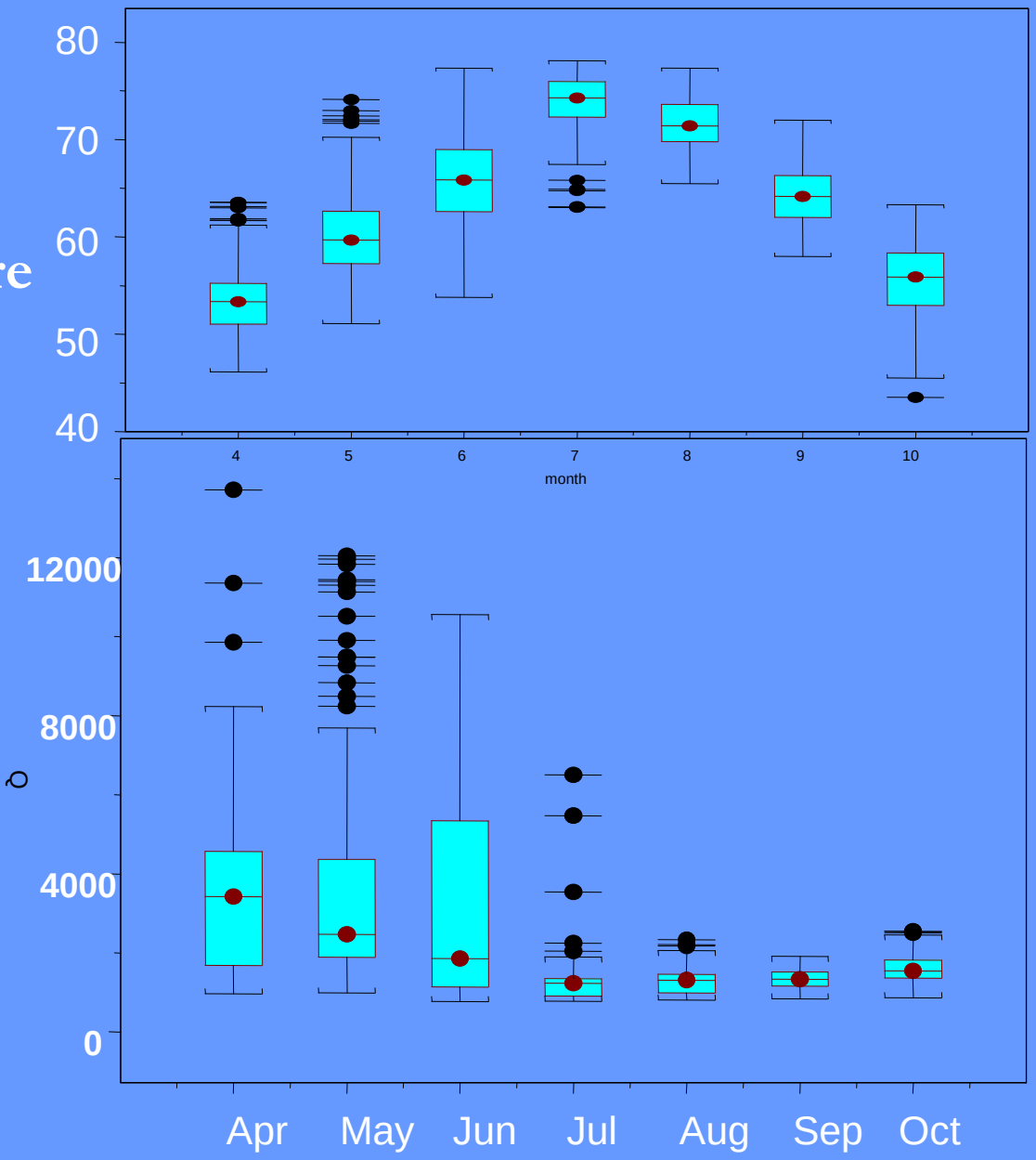
Section 5



Monthly water temp. and flow at Yakima R. at Grandview,WA

Water Temperature (F)

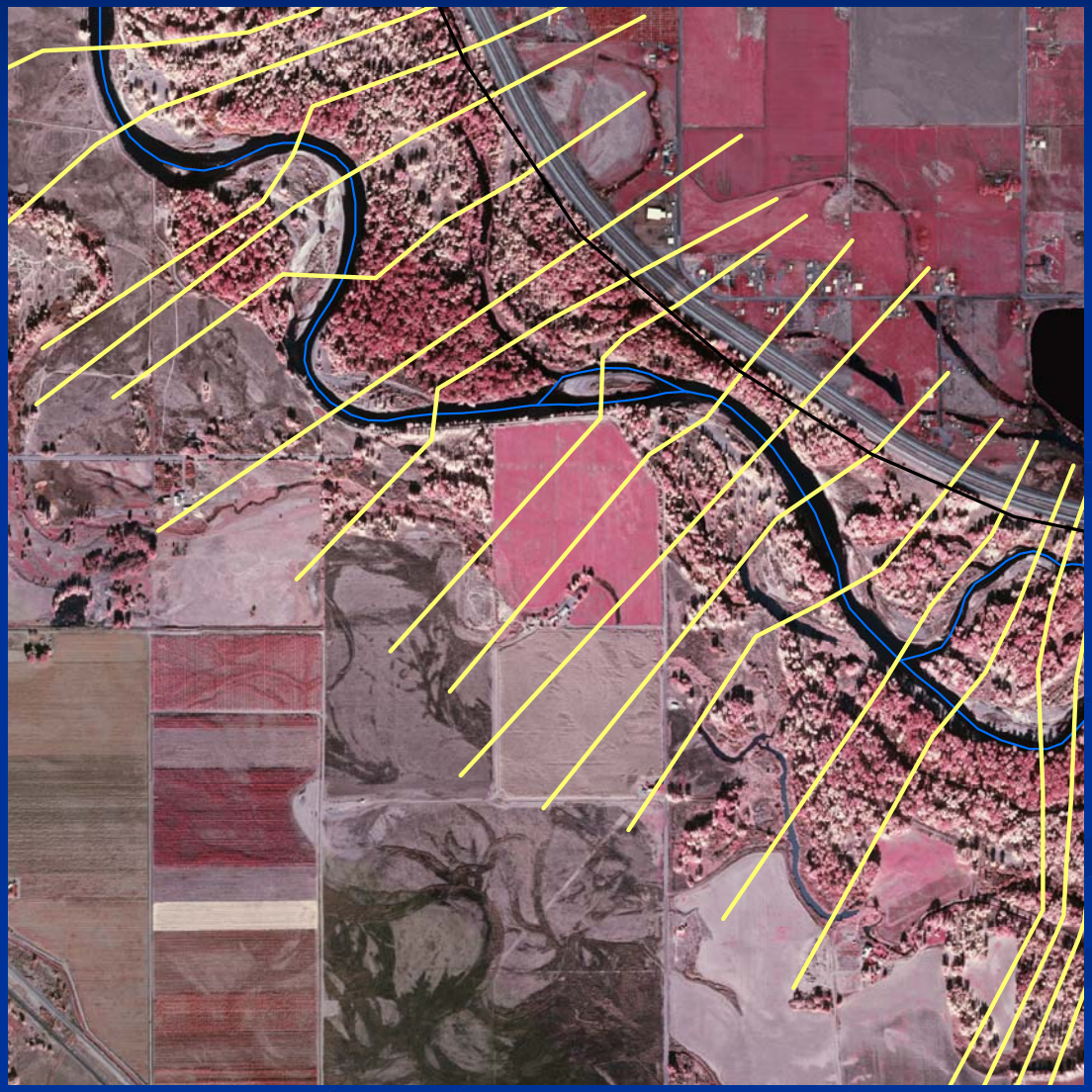
Flow (cfs)



Water Temperature Response to Meteorology Inputs (preliminary results)

Parameter and % increase	% change in Daily Max. Temp. for 2005				% change in Daily Mean Temp. for 2005	
	Site J4		Site J5		Site YGVW	
	Season	July	Season	July	Season	July
Air Temperature +5%	1.71	2.02	1.72	1.95	2.03	2.47
Solar Radiation +5%	1.31	1.62	1.40	1.56	1.22	1.65
Relative Humidity +5%	0.61	0.81	0.62	0.78	0.76	0.82
Wind Speed +5%	-0.24	0.00	-0.26	-0.39	-0.28	-0.41

HEC-RAS x-sections for width-flow relationship



$W = a * Q^b$;

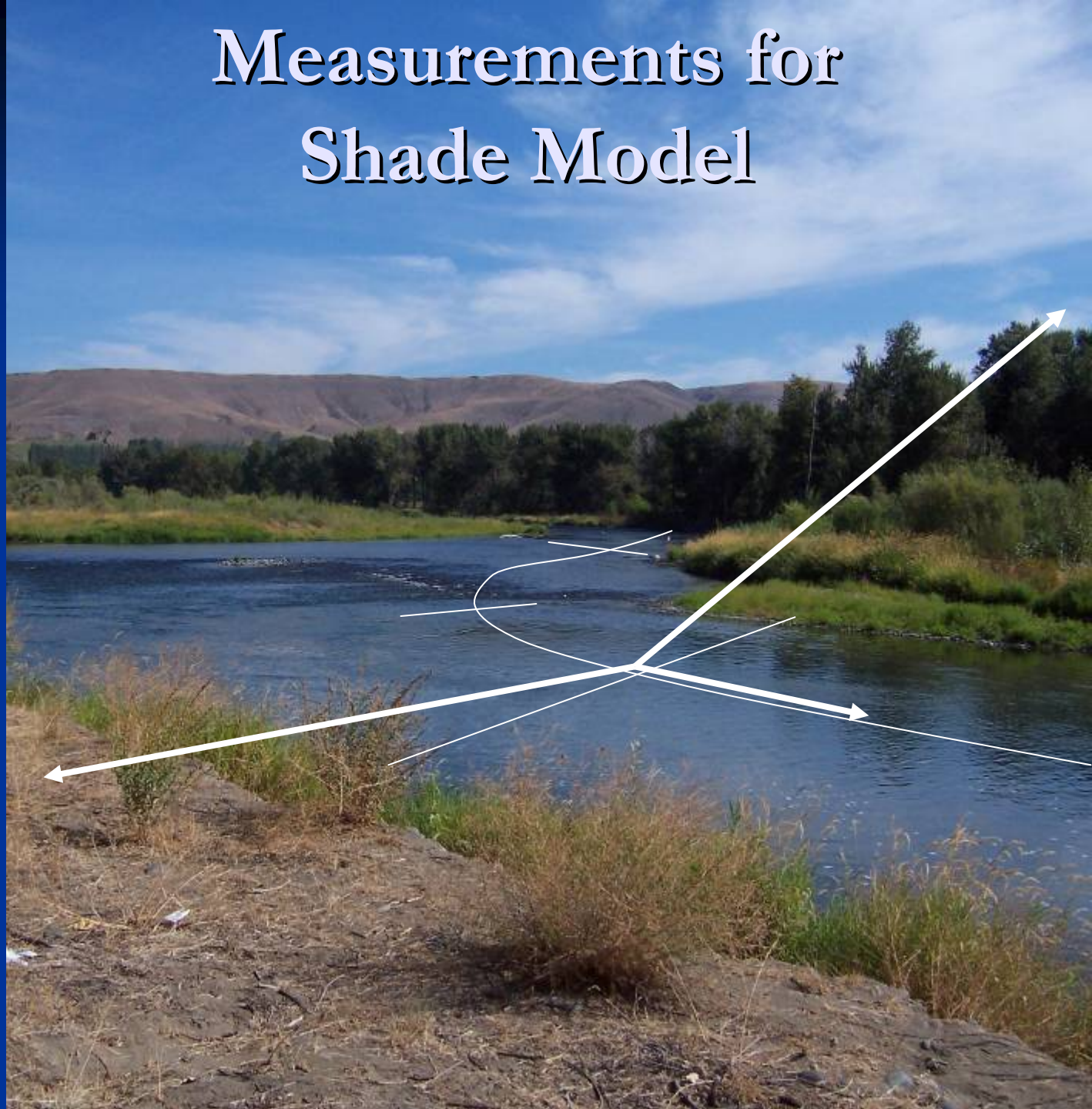
where W is width
Q is discharge,

and a and b are coefficients

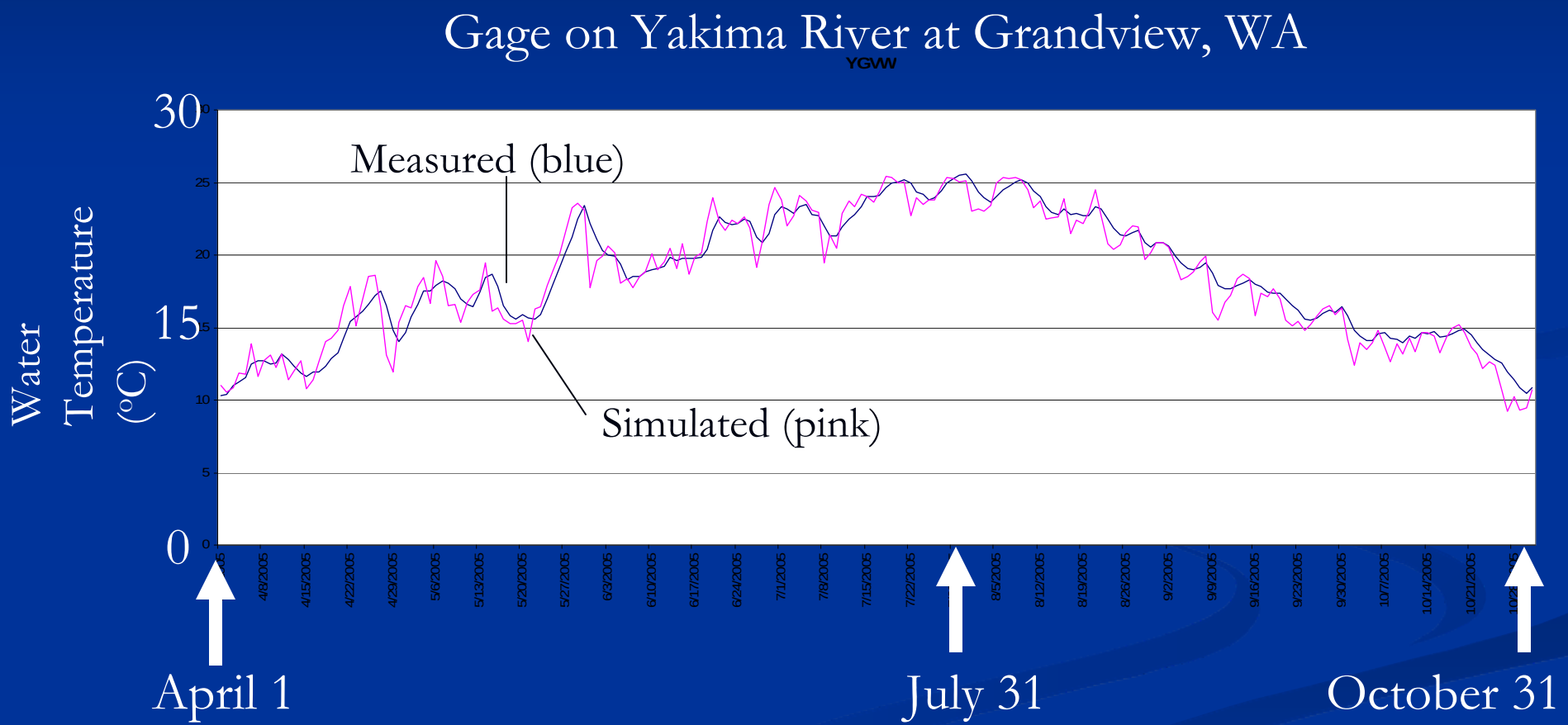
Measurements for Shade Model

For each site

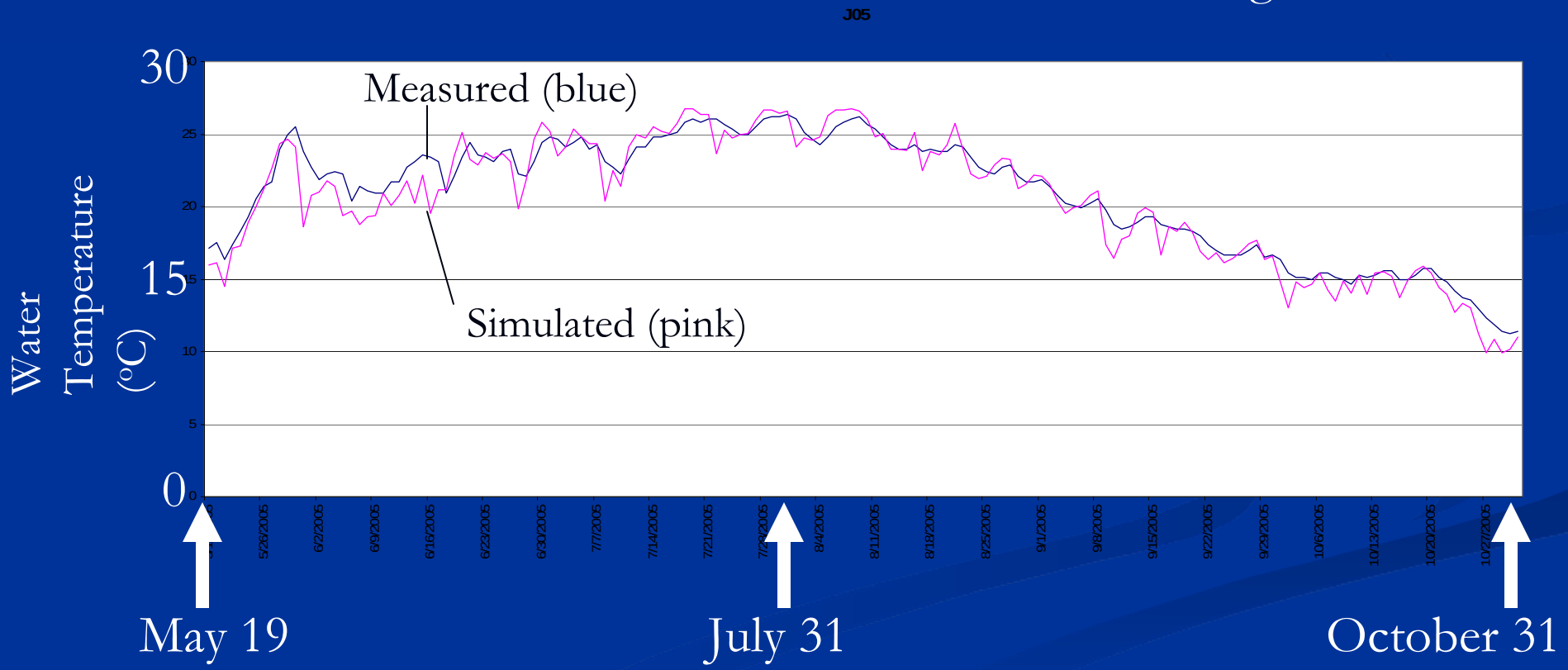
- Latitude
- Azimuth
- Stream width
- Topographic Altitude
- Vegetation
  - Height
  - Offset
  - Density



Simulated and Measured Daily **Average** Water Temperature



Simulated and Measured Daily **Maximum** Water Temperature



Model Summary

- Water temperature most sensitive to changes in air temperature and solar radiation, more sensitive during periods of low flow
- Shading may cool water temperature 0.5 C in upper sections, less than 0.5 C in lower sections
- Model simulated seasonal patterns for 2005
- Error high when predicting daily values